HAWAII RIVER BASINS

HAWAII

PLANNING STATUS REPORT

WATER RESOURCE APPRAISALS FOR HYDROELECTRIC LICENSING

FEDERAL POWER COMMISSION

BUREAU OF POWER

1966

WATER RESOURCE APPRAISALS FOR HYDROELECTRIC LICENSING

PLANNING STATUS REPORT

This is one of a series of Planning Status Reports being prepared for major river basins in the United States. These reports constitute the first step in a program of water resource appraisals for hydroelectric licensing. They are prepared by the Bureau of Power of the Federal Power Commission to identify those basins most in need of additional planning studies to provide information needed by the Commission in its hydroelectric licensing and other work. The Planning Status Reports show data on existing water resource developments and known potentials, summarize the license status of non-Federal hydroelectric developments, review past and current planning studies, and identify the needs for additional planning. The information presented in these reports is abstracted from available sources and its assembly involves no new studies.

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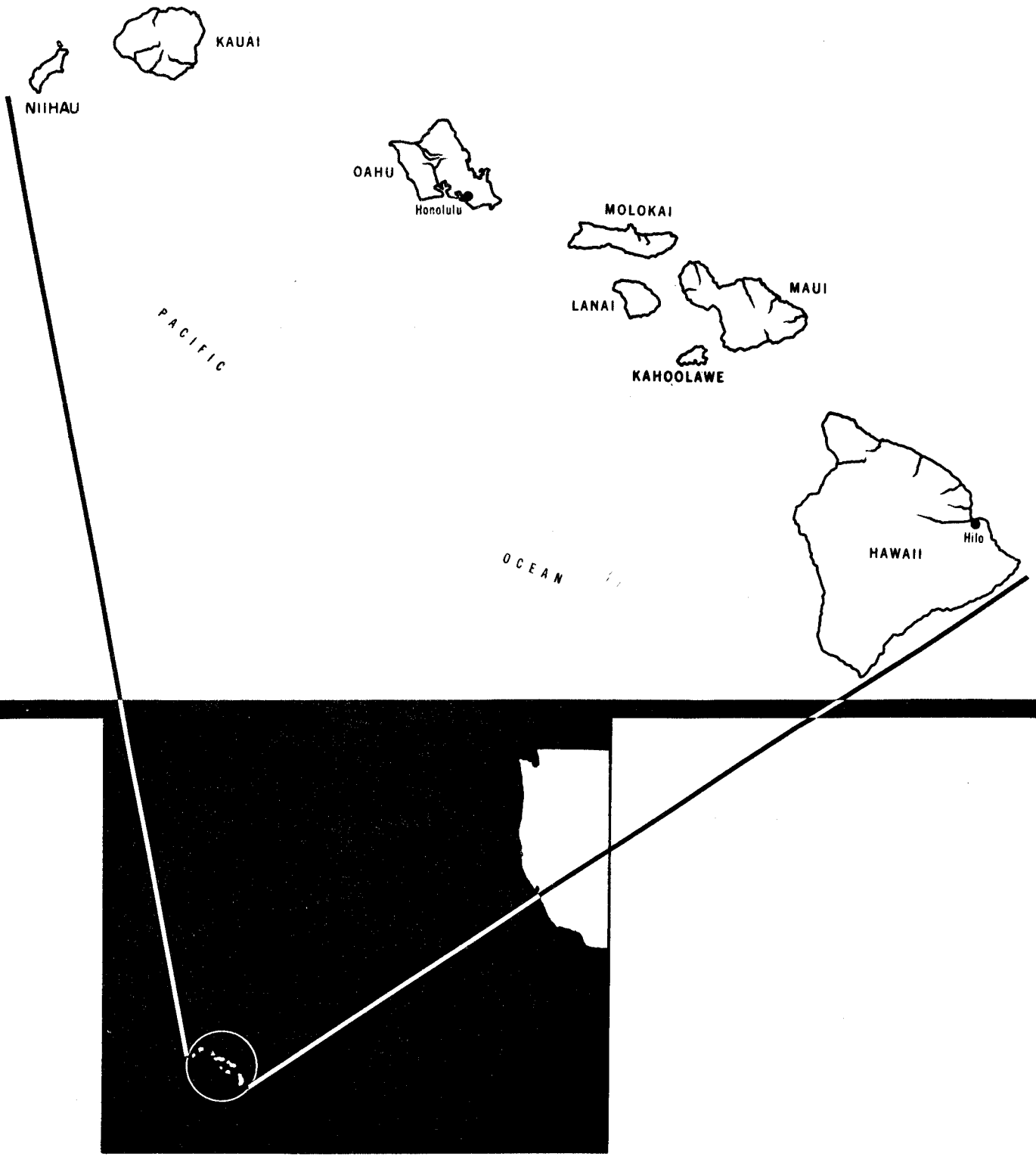


DESCRIPTION OF THE BASIN

Hawaii is the oceanic state of the United States consisting of a group of islands in the Pacific Ocean, the easternmost end of the chain being about 2,400 statute miles from California. The main group, lying south of the Tropic of Cancer, includes from east to west the islands of Hawaii, Maui, Kahoolawe, Lanai, Molokai, Oahu, Kauai, and Niihau. The Hawaiian Islands are part of a mostly submerged volcanic mountain range stretching some 2,000 miles across the floor of the north-central Pacific. Elevations have built up from the ocean floor, some 18,000 feet below sea level, to a maximum height of nearly 14,000 feet above sea level — a total of 32,000 feet. At some points, the mountains form islands or atolls based on craters which are near the surface. At the highest point in the chain, a number of large peaks protrude above the ocean. These mountain-top islands constitute the State of Hawaii.

The area of the Hawaiian Islands, including the outlying islands, is 6,454 square miles, slightly more than the combined areas of Connecticut and Rhode Island. Termed the "Big Island," the Island of Hawaii has an area of 4,030 square miles, or about two-thirds of the total land surface of the state. The population of this island at the beginning of 1965, was 61,335. Maui, second largest island of the group, is 728 square miles in area, and has a population of 38,930. It is famous for having one of the largest dormant volcanoes in the world. Oahu is the hub of economic and political activity within the state. The island is third in size with an area of 604 square miles, and has a population of 560,575. Approximately 70 percent of this population is in metropolitan Honolulu, the capital of Hawaii. The island of Kauai is 553 square miles in area, with a population of 26,010. Comprising an area of 260 square miles, Molokai is fifth in size of the islands. The population at the beginning of 1965 was 5,682. Lanai, the sixth in size, is 141 square miles in area, with a population of 2,713. This island is owned by the Dole Pineapple Company, and is one of the largest pineapple plantations in the world. The island of Niihau is privately owned and little developed compared with the other islands in Hawaii. It is 72 square miles in area and has a pure native Hawaiian population of about 300. The island of Kahoolawe, smallest of the eight islands, is 45 square miles in area. It is a barren, uninhabited island under military control.

Although in the Tropics, trade winds and the proximity of the cool currents of the Bering Sea provide the state with a mild and temperate climate. Hot, humid weather is rare, and frost is unknown at elevations lower than 2,500 feet. Deviations in the normal weather pattern are caused by cyclonic storms associated with cold fronts out of the north and with tropical disturbances out of the east, south, or west. Most of the interruptions of the normal trade winds weather (trade winds prevail about 80 percent of the time) occur during the winter months from cyclonic disturbances passing over or near the Islands. Such disturbances, known as kona storms, are characterized by several days of heavy precipitation with strong winds from south to southwest. As the moisture-laden trade winds strike the island mountains, they are deflected upward and cooled, causing the moisture to fall as rain. This orographically produced rainfall

DESCRIPTION OF THE BASIN

is largely responsible for the extreme rainfall variation in the islands. The U. S. Geological Survey reports an average annual rainfall of over 460 inches on Mt. Waialeale, and a recorded high of 624 inches in 1948. Mt. Waialeale, elevation 5,075 feet, is in the central summit area of Kauai. While Mt. Waialeale is considered one of the wettest places in the world, the average rainfall just 17 miles distant on the leeward side in the coastal town of Kekaha is only 22 inches per year.

Because of the mountainous topography of the Islands, most of the surface runoff occurs in numerous, short, but steep-graded streams, which originate in the mountains and flow radially out to the sea. Many of the streams are intermittent.

The economy of Hawaii is highly specialized in agricultural specialties - sugar, pineapple, and related food processing industries - with limited activity in other fields of manufacture, and in tourism and defense activities. The United States defense activity for the entire Pacific basin is headquartered on the Island of Oahu and represents the largest single source of income and employment in Hawaii. The 1960 census showed a total population of 632,772 for the State of Hawaii. This was a growth of 26.6 percent from a 1950 population of 499,794. The estimated 1960 civilian population was 577,000.

Transportation is, in a very real sense, the "lifeline" of the economy of Hawaii. Continuing good sea transportation and the rapid development of air transportation have firmly established the Islands as "the crossroads of the Pacific." Highways, urban thoroughfares, and rural roads are, in general, of modern construction and well-adapted to the transportation needs of the Islands. Transportation between the Islands is mainly by air.

EXISTING WATER RESOURCE DEVELOPMENTS

Hawaii has no river systems suitable for multiple-purpose use such as are found on the mainland. Generally, the valleys are narrow and steep, and the volcanic formations are highly permeable, making infeasible the construction of impounding reservoirs. There are a few exceptions to this general rule where reservoirs can be constructed, principally on the Island of Kauai. Data for the existing reservoirs with storage capacities greater than 5,000 acre-feet are given in Table 1.

EXISTING WATER RESOURCE DEVELOPMENTS

Table 1

Existing Reservoirs
State of Hawaii

Name	Owner	Stream	Drain. Area Sq.Mi.	Purpose	Storage Capacity (acre-ft.) Usable	Total
Koloa Marsh	Grove Farm Co.,Inc.	Marsh Area	2	Irrig.	7,256	7,686
Wahiawa	Waialua Agric. Co., Ltd.	Kaukonahua	17	Irrig.	7,750	7,795
Waihee Tunnel	Honolulu Bd. of Water Supply	Waihee	N.A.	Water Supply	6,660	6,660
Waimea Res.	Hawaii Irr. Auth.	N.A.	N.A.	N.A.	N.A.	N.A.
Waialua	N.A.	N.A.	N.A.	N.A.	N.A.	7,800

N.A. - Not available.

Streamflow is largely unregulated and hydroelectric plants' capacities are for the most part based on the minimum streamflows. Further, the priority of irrigation requirements at the higher elevations takes much of the water ahead of the forebay, so only part of it would be available for power. At the present time, only three islands have developed hydroelectric projects. These are Hawaii with 5,505 kw installed capacity, Maui with 5,400 kw, and Kauai with 8,116 kw, making a total of 19,021 kw. These projects are listed in Table 2 and shown on Figures 1 and 2. As shown in Table 2, most of the projects are operated by sugar plantations for their own use; however, plants owned by public utilities are included on the Island of Hawaii.

Methods of obtaining and using water vary widely. There are no large lakes; however, underground water is found in artesian basins and in water soaked rocks in natural reservoirs beneath the mountains and adjacent plains. In areas where mountain waters have not been discovered, people are dependent upon rain water caught in individual tanks, on rooftops, or upon streams. Water diverted from surface supplies represents approximately 60 percent of the gross water utilization of the state. The balance comes from ground water sources. In contrast, on the mainland, approximately 80 percent of the water utilized is derived from surface sources.

Due to the relatively small drainage basins and the generally pervious rock formations, unfavorable to impounding reservoirs, flood control measures have been largely confined to localized channel and levee works, land treatment, flood plain zoning and construction of a few small projects. The Corps of Engineers, the State, and local agencies with assistance of the Soil Conservation Service have established extensive flood control programs for the five major islands which include coastal areas subject to damage from abnormal tidal actions, such as high seas, hurricanes, and

EXISTING WATER RESOURCE DEVELOPMENTS

Table 2
Existing Hydroelectric Plants
State of Hawaii

Project	Stream	Owner	Owner Class	Static Head Feet	Installed Capacity KW	First Year Operated
Island of Hawaii						
Mauna Kea Sugar Co. (South)	Wailuku	MKSS	I	207	80	N.A.
Puueo	Wailuku	HIEL	P	400	2,250	1918
Waiau	Wailuku	HIEL	P	322	1,100	1921
Mauna Kea Sugar Co. (North)	Kapue	MKSN	I	207	125	N.A.
Hakalau	Wailuku	HASC	I	277	150	N.A.
Paauhau	Lo. Hakakua Ditch	PASC	I	473	150	N.A.
Honokaa	Lo. Hamakua Ditch	HOSU	I	415	800	N.A.
Union	Kohala Ditch	KOSC	I	N.A.	500	1934
Hawi	Kohala Ditch	KOSC	I	N.A.	350	1935
Subtotal					5,505	
Island of Maui						
Kauaula	Kauaula	PIMC	I	533	500	1918
Paia	Wailoa Ditch	HACS	I	280	900	1912
Kaheka	Wailoa Ditch	HACS	I	660	4,000	1925
Subtotal					5,400	
Island of Kauai						
Wainiha	Wainiha	MBSC	I	560	3,600	1910
Waimea	Waimea	KESC	I	N.A.	1,000	1954
Waiawa	Waimea	KESC	I	200	500	1908
Nonopahu	Makaweli	OLSC	I	N.A.	500	1920
Kalaheo	Alexander Res.	MBSC	I	700	1,000	1928
Malumalu	Waihahanu	GRFC	I	150	216	1919
Lower Lihue	S.F. Wailua	LIPC	I	N.A.	800	1941
Upper Lihue	Waihai	LIPC	I	560	500	1930
Subtotal					8,116	
Total - 20 Projects - Hawaiian Islands					19,021	

Abbreviations:

MKSS - Mauna Kea Sugar Co. (South)
HIEL - Hilo Electric Light Co., Ltd.
MKSN - Mauna Kea Sugar Co. (North)
HASC - Hakalau Sugar Co.
PASC - Paauhua Sugar Co.
HOSU - Honokaa Sugar Co.
KOSC - Kohala Sugar Co.
PIMC - Pioneer Mill Co., Ltd.
HACS - Hawaiian Commercial & Sugar Co.
MBSC - McBryde Sugar Co., Ltd.
KESC - Kekaha Sugar Co., Ltd.
OLSC - Olekele Sugar Co., Ltd.
GRFC - Grove Farm Co., Ltd.
LIPC - Lihue Plantation Co.
N.A. - Not Available
I - Industrial
P - Privately-owned utility

tsunamis. Extensive work on navigation works and beach erosion control is also being done by the Corps and the State. As can be inferred from the preceding discussion, the development of conventional hydroelectric power will be greatly restricted, if not virtually ruled out, because of the relatively small surface water supplies available (even these may be appropriated for irrigation use high up in the watersheds), and the high unit costs of small hydroelectric developments.

STATUS OF HYDROELECTRIC LICENSING

No hydroelectric plants in the Hawaiian Islands are licensed by the Commission, and no applications for license are pending.

WATER RESOURCES PLANNING

Prior Studies and Reports

The State of Hawaii Department of Land and Natural Resources has published water resources planning studies for Hawaii. The reports on these studies are briefly described below.

Water Resources in Hawaii, Bulletin B-14, March 1959. This report combines a narrative and statistical coverage of the water resources of the State. It includes a discussion of the water development problems in Hawaii and points out conservation measures that could be adopted or expanded.

Flood Control and Flood Water Conservation in Hawaii, Bulletin B-15; Volume I - Floods and Flood Control, Volume II - General Flood Control Plan for Hawaii; January 1963. A flood control plan, presented by islands and watershed groupings, suggests improvements to existing flood control programs, both active and inactive, and the establishment of new programs. No reservoirs were recommended as a measure of improvement.

Kokee Water Project, Island of Kauai, Hawaii, Report R-22, 1964. This report was prepared jointly by the State of Hawaii and the Bureau of Reclamation. Construction of the Kawaikoi Dam and Reservoir and the Puu Opae power plant was proposed for irrigation, hydroelectric power, fish and wildlife enhancement, and recreation in the western part of the Island of Kauai. Only incidental flood control was found practical.

Current Studies

The Corps of Engineers has recently initiated a study of multiple-purpose development of water resources in Waipio Valley on the Island of Hawaii. Preliminary field work has been completed and design has been initiated to enable an early construction start in 1966 to collect and pump spring water from the head of Waima Valley (Waipio) into the Lower

Hamakua Ditch. Water requirements necessitate supplemental supply to maintain adequate levels.

The State Department of Land and Natural Resources is developing long-range comprehensive water plans for each of the major islands in the state. These plans will cover all aspects of water occurrence, availability, utilization, development and conservation, with underlying considerations for sound and orderly development of Hawaii's water resources. The plans will begin with the Island of Molokai followed by the Island of Hawaii.

POTENTIAL WATER RESOURCE DEVELOPMENTS

The upper tributary streams of the Waimea River on Kauai may offer the best and perhaps the only favorable sites in the state for new impounding reservoirs. Some additional water is developed from swamps, both those found in the mountainous areas and those at lower elevations. The state has given consideration to developing water in Alakai swamp on Kauai and the mountain swamp on Molokai located between Waikolu and Pelekunu Valleys. Other swamp areas have potentials for development, but do not represent major sources of supply.

The State of Hawaii Department of Land and Natural Resources is actively considering the Kokee Water Project on the Island of Kauai. This is a multiple-purpose water project, the first of its kind in Hawaii. Proposed are irrigation, hydroelectric power, fish, wildlife, recreation, and flood control developments. This project is also geared for Federal financial assistance. As proposed, the project would include the Kawaikoi multiple-purpose reservoir on Kawaikoi Stream, certain water conveyance and distribution facilities to serve irrigated lands, and the Puu Opae hydroelectric power plant. The power plant would utilize a drop of 960 feet in the water conveyance system. Installed capacity would be 10,000 kw and the estimated average annual generation about 29,000,000 kwh, equivalent to an annual plant factor of 33 percent. The water would be obtained by diversions from Mohihi Stream, Waiakoali Stream, Kawaikoi Stream, Kauaikinana Stream, Kokee Stream, and minor intermediate tributaries. These streams are the principal source of Poomau Stream, the major tributary to Waimea River which enters the Pacific Ocean near the Town of Waimea. The Kokee Water Project utilizes about a third of the Alakai swamp area. This project is shown on Figure 1.

Additional ground water can be developed in various areas. Most of this water is basal water in the interior parts of the various islands where deep wells would be required. As the demand for more water increases, the economics of pumping this inland water may change to make such developments feasible.

POTENTIAL WATER RESOURCE DEVELOPMENTS

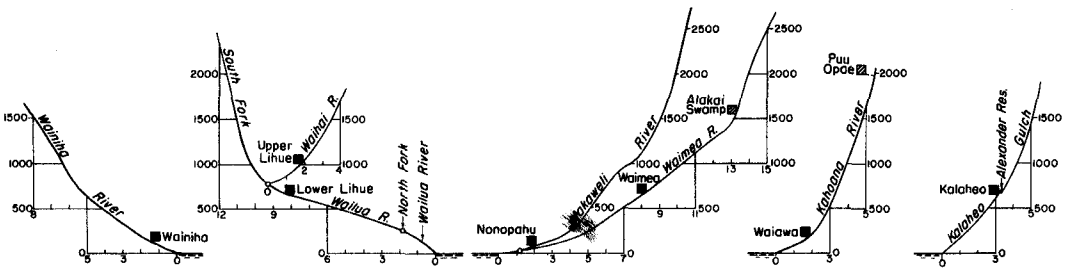
Some additional dike-impounded water exists on most of the islands. Its further development will largely depend on economics.

NEED FOR ADDITIONAL STUDIES

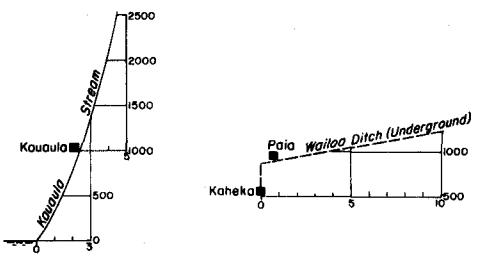
Hawaii will need more water in the future to meet increasing demands for municipal, industrial, and agricultural uses. In general, Hawaii's water supply problems are not due to lack of rainfall but to inequalities in the distribution of rainfall. Various "dry" areas in the state have further development potentials for residential purposes, tourist centers, industrial and agricultural uses, if water can be made available. A lack of adequate water supply systems is a retarding influence for industrial development on Oahu, tourist development on Maui and Hawaii, and agricultural expansion into new areas on all islands. Some districts suffer periodically from droughts while others suffer from extremely heavy rainfall. Studies are needed to assure that plans for the exportation of water to "dry" areas are coordinated with plans to meet the local needs.

The state believes that there may be a potential for small-scale hydroelectric power development in many areas of the state. Economic and engineering studies are needed to determine the feasibility of any new development.

The capacities of the Islands' hydroelectric power installations are small, and available information indicates that the total hydroelectric power potential of the state is not large. There are no hydroelectric projects under FPC license and no license applications are pending.



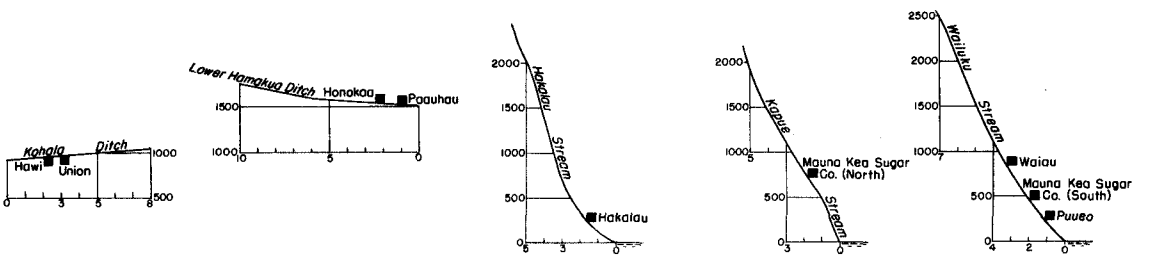
ISLAND OF KAUAI



LEGEND

STATUS	EXISTING	POTENTIAL
POWER PLANT	■	▨
RESERVOIR	⚡	

ISLAND OF MAUI



ISLAND OF HAWAII

FEDERAL POWER COMMISSION

WATER RESOURCE APPRAISALS FOR HYDROELECTRIC LICENSING

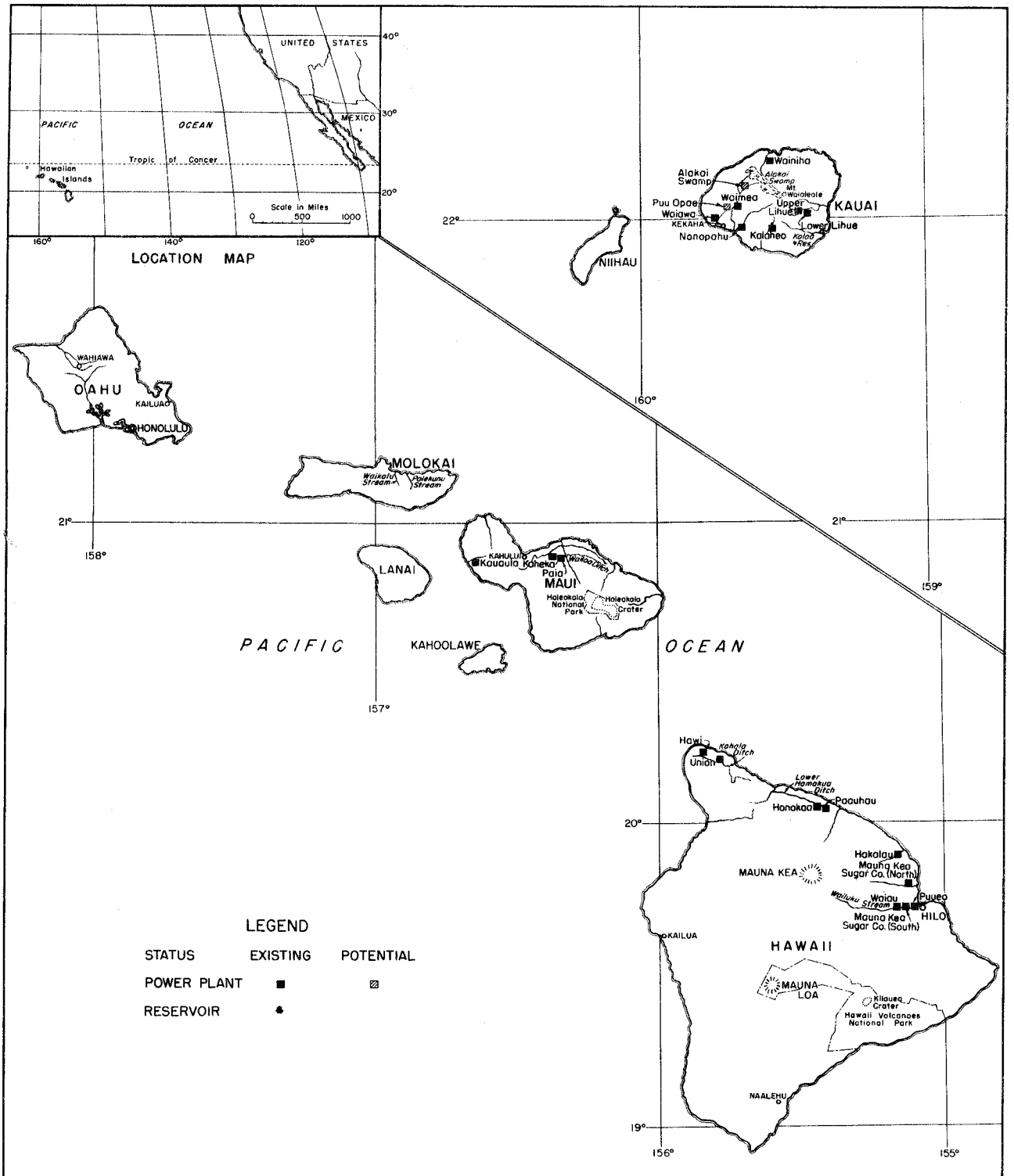
SUMMARY OF PLANNING STATUS

STATE OF HAWAII

PROFILES

JUNE 1966 E H

FIGURE 1



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SUMMARY OF PLANNING STATUS

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FIGURE 2